SIMULATING TITAN'S UPPER ATMOSPHERE AND ITS PHOTOCHEMISTRY IN THE VACUUM ULTRA-VIOLET (VUV). Tigrine, S[1] , Carrasco, N[1], Vettier, L[1] , Nahon, L[2]
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Abstract: Titan, the largest moon of Saturn, has a dense atmosphere whose upper layers are mainly composed of methane (CH_4) and molecular nitrogen (N_2). The Cassini mission revealed that the interaction between those molecules and the solar VUV radiation, as well as the electrons from Saturn's magnetosphere, leads to a complex chemistry above an altitude of 800km [1]; [2]; [3]; [4].

Cassini instruments such as INMS or CAPS revealed that this naturally ionized environment contains heavy organic molecules like benzene (C_6H_6) even at altitudes higher than 900 km [5]. This is consistent with an initiation of the aerosols in Titan's upper atmosphere. Moreover, some N-bearing molecules of pre-biotic interest such as NH_3 have been detected by the instruments; but in quantities that do not match the theoretical models [3]; [6].

The presence of those molecules makes Titan a natural laboratory to witness and understand prebiotic-like chemistry but despite all the data collected, all the possible chemical processes in such a hydrocarbon-nitrogen-rich environment are not precisely understood.

This is why Titan's atmosphere simulation experiments are of high interest.

In order to reproduce the photochemistry occurring in this kind of upper atmospheres in the more precise way, we designed a gas reactor named APSIS for Atmospheric Photochemistry SImulated by Synchrotron. APSIS is to be coupled with a VUV photon source as N_2 needs wavelengths shorter than 100 nm in order to be dissociated.

Previously, APSIS has been used with a synchrotron beamline (DISCO at the SOLEIL synchrotron facility) leading to the formation of reaction products up to C5 [7]. Among those organic compounds, some nitrogen-bearing species have been identified such as HCN, CH_3CN and C_2N_2.

The aim now is to understand the key processes in the formation of those heavy compounds.

One previous experiment, described in [8], showed that, at 60 nm, N_2 ionization regime is more efficient than at 85 nm to form the heavy organic species (up to C8 such as benzene or toluene) one can observe in Titan's atmosphere. That supports the question about the importance of ions in this organic chemistry and the formation process of the aerosols.

However, only two wavelengths were investigated, 60 and 85 nm. The VUV source has to be tuned at specific wavelengths in order to test different photochemical regimes and measure their impact. To do so, we complementary developed a surfatron source with noble gases for the micro-wave discharge. For example, neon has two resonance lines at 73.5 and 74.3 nm which allow us to dissociate and/or ionize both CH_4 and N_2 (see Figure 1). We will present here our first experimental results obtained with APSIS coupled with this surfatron and then discuss them regarding the Cassini data and other previous laboratory studies.

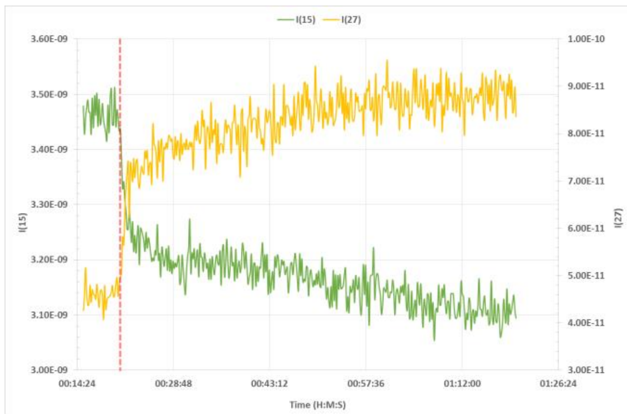

Figure 1. Time monitoring of methane consumption (green line, left axis) and HCN production (yellow line, right axis) with the APSIS reactor and the neon VUV source. The red line shows the irradiation start.

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